Resolving Iron Deficiency in *Wrightia religiosa* by Foliar Analysis and its Amelioration Using an Iron Chelate as a Soil Additive

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Abstract

Iron deficiency in *Wrightia religiosa* was associated with a suboptimal level of "active Fe" in the young leaves. Soil application of Nervanaid Fe 132, a carrier of FeEDTA, at 10 g per plant and particularly at 20 g per plant helped chlorotic plants to regain their healthy vigour. Treatment brought the "active Fe" to levels comparable to or above those of the control.

Introduction

Wrightia religiosa is a popular ornamental shrub in Singapore because of its fragrant flowers and ease of propagation. It is also a popular choice for bonsai. Recently, a noticeable population of *Wrightia* established in parks and along roadsides has been affected by iron deficiency. Iron deficiency was confirmed by partial recovery of deficient plants upon foliar treatment with $FeSO_4$.

Iron deficiency symptoms manifest themselves initially as interveinal chlorosis of the young leaves as iron does not move readily from old leaves to the young flushes. Iron is required for chlorophyll synthesis and when it is present at suboptimal level, insufficient chlorophyll is synthesized thus causing chlorosis (Plate 1). As deficiency becomes more advanced and acute, the affected young leaves grow to become the older affected leaves, while the newly emerged flushes remain chlorotic. Eventually, the entire plant assumes an overall chlorotic appearance (Plate 2). In very severe cases, the leaves become almost bleached of colour and have random necrotic spots. Dieback of growing tips is common (Plate 3).

A spectrum of physical and chemical soil properties has been identified as conducive to iron deficiency in plants (Chaney, 1984; Lindsay, 1984; Lindsay and Schwab, 1982; Mortvedt et al., 1977 Vejsadova et al., 1982). The iron chelate, FeEDTA, is known to be an effective soil additive in overcoming iron chlorosis where the soil pH is below 6.70 (Lindsay and Schwab, 1982). This investigation critically examined the efficacy of this fertilizer in resolving iron chlorosis in *Wrightia* thriving on acid soil.

Materials and Methods

The trial area was located in a park where there was a concentration of iron-deficient *Wrightia* plants. The sites were characterized by acidic soil pH values ranging from 4.00 to 6.70.

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The iron chelate, Nervanaid Fe 132 (a.i. FeEDTA, 12.7% Fe) was tested at the rates of 10 g per shrub and 20 g per shrub respectively. Five trial plants were used for each treatment and control. The chelate was dissolved in 5 l of tap water and then poured evenly around the area spanned by the plant. In the case of the control, only tap water was used. Treatment began at zero time after the first foliar sampling and was thereafter maintained at weekly intervals for 4 weeks. Where *Wrightia* plants existed in groups, each trial plant was selected in such a manner that it was separated from the next by at least one guard plant so that the risk of spillover of treatment effect was minimized.

From preliminary analyses, no relationship was discernible between total foliar Fe content and iron chlorosis. In many cases, chlorotic plants were found to have significantly more total Fe than their healthy counterparts. This was consistent with the findings of Bennett (1945) and DeKock et al. (1979). However, the "active Fe" fraction extractable by 1N HCl showed distinct differences between healthy and deficient young leaves. This parameter was monitored during the course of treatment.

Foliar sampling was done three times i.e. at zero time, week 2 and week 4. Only the first two pairs of fully-developed young leaves were sampled for analysis. These were washed with Teepol (a non-ionic detergent), 0.1N HCl and finally rinsed with deionized water. Fresh subsamples were cut into small pieces with a pair of stainless steel scissors, dried between filter papers and weighed out in duplicates. Each 1 g sample was extracted with 20 ml. of 1N HCl for 24 hours with occasional agitation (Takkar and Kaur, 1984). "Active Fe" was analysed by the PU9000 AA spectrometer immediately after filtration.

Results and Discussions

Results were subjected to the Duncan Multiple Range Test for significance and are presented in Table 1 and Histogram 1.

Table 1

Changes in the "active Fe" fraction in ppm in fresh young leaves upon treatment with Nervanaid Fe 132

Treatment \ Time (Week)	0	2	4
Control	19.96a	22.94a	22.34a
10 g chelate	13.40b	19.40a	23.48a
20 g chelate	11.12b	22.96a	30.36b

For each column: Values with the same letter are not significantly different at $P < 0.01$.

Before treatment at zero time, iron-deficient plants had significantly lower 1N HCl – extractable Fe or "active Fe" than the control plants (Table 1 and Histogram 1). A typical iron-deficient *Wrightia* plant is depicted on Plate 1.

After two applications of the iron chelate, foliar analysis revealed that the "active Fe" fractions in treated plants became comparable to those in the controls at week 2. The significant increase in "active Fe" in treated plants concurred with a pronounced recovery from iron chlorosis. This was especially remarkable with the 20 g treatment. At this stage, the new flushes assumed the healthy green colouration.

However, the older leaves remained chlorotic. The recovering process appeared to take effect over the first and second week (Table 1 and Histogram 1).

At week 4, the treated plants had attained satisfactory recovery. With the 20 g chelate treatment, the "active Fe" had significantly risen to 35.9% above that of the control. "Active Fe" contents in the controls and plants treated with 10 g chelate were similar although somewhat higher in the latter. (Table 1 and Histogram 1).

The longevity of treatment effect was monitored after the cessation of treatment at week 4. Plants treated with 20 g chelate remained healthy for at least 6 months whereas those treated with 10 g chelate reverted to the original state of iron chlorosis after 2–3 months.

HISTOGRAM 1 :

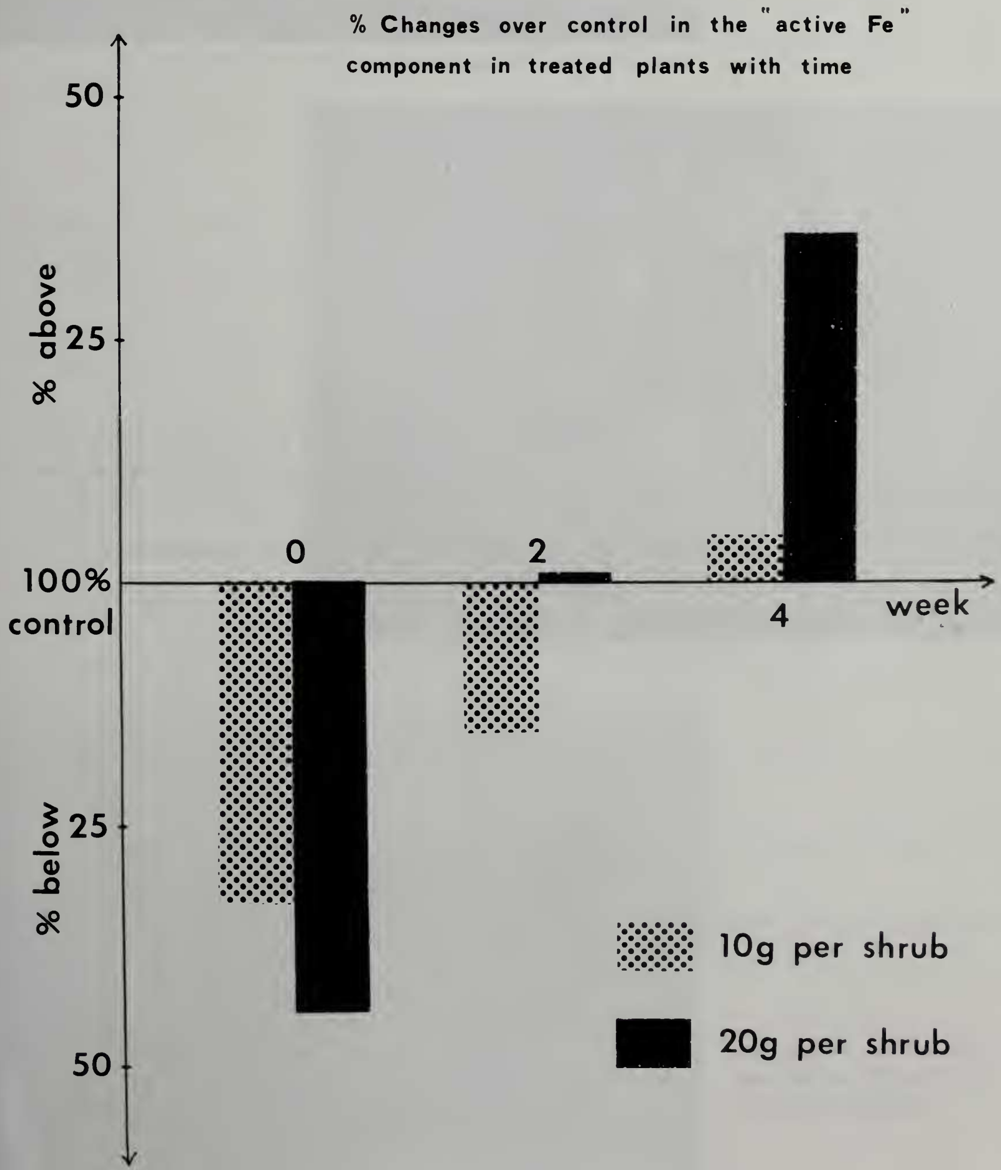

Plate 1: Mild iron deficiency in *Wrightia religiosa*

Plate 2: Advanced iron deficiency in *Wrightia religiosa*

Plate 3: Dieback of growing tips in advanced iron chlorosis in *Wrightia religiosa*

Conclusion

In agreement with the findings of Hellin et al. (1987) and Wallace et al. (1984), the present study showed positive results in the amelioration of iron chlorosis in *Wrightia religiosa* with FeEDTA as a soil additive where the soil pH was acidic. Both levels of Nervanaid Fe 132 tested were found to be effective in correcting iron deficiency. The higher dosage, however, should be used as its ameliorative effect was more persistent.

It was possible to resolve iron chorosis in *Wrightia* by determining the 1N HCl - extractable Fe or "active Fe". The likely sufficient level of this component that is compatible with normal growth in *Wrightia* is about 20 ppm on a fresh weight basis (Table 1).

Further investigations are in progress to resolve iron chlorosis in *Wrightia* by soil analysis. The ultimate solution for iron chlorosis in *Wrightia* lies in determining whether the deficiency is true or induced. If it is induced deficiency, the cause needs to be ascertained so that suitable corrective measures could be administered accordingly.

References

Bennet, J.P. (1945). Iron in leaves. *Soil Sci.*, 60, 91–105.

Chaney, R.L. (1984). Diagnostic practices to identify iron deficiency in higher plants. *J. Plant Nutr.*, 7(1–5), 47–67.

DeKock, P.C., Hall, A. and Inkson, R.H.E. (1979). Active iron in plant leaves. *Ann. Bot.*, 43, 737–740.

Hellin, E., Ureha, R., Sevilla, F and Alcaraz, C.F. (1987). Comparative study on the effectiveness of several iron compounds in iron chlorosis correction in citrus plants. *J. Plant Nutr.*, 10(4), 411–421.

Lindsay, W.L. (1984). Soil and plant relationships associated with iron deficiency with emphasis on nutrient interactions. *J. Plant Nutr.*, 7(1–5), 489–500.

Lindsay, W.L. and Schwab, A.P. (1982). The chemistry of iron in soils and its availability to plants. *J. Plant Nutr.*, 5(4–7), 821–840.

Mortvedt, J.J., Wallace, A. and Carley, R.D. (1977). Iron, the elusive microelement. *Fertilizer Solutions*, 21(1), 26, 28, 30, 32, 34, and 36.

Takkar, P.N. and Kaur, N.P. (1984). HCl method for Fe^{2+} estimation to resolve iron chlorosis in plants. *J. Plant Nutr.*, 7(1–5), 81–90.

Vejsadova, H. and Lastuvka, Z. (1982). The importance of FeEDTA for reversibility and phosphate-induced chlorosis in maize (*Zea mays* L.). *Biologia Plantarum* (Praha), 24(6), 401–406.

Wallace, A., Wallace, G.A., Wood, R.A. and Abou-Zamzam, A.M. (1984). Uptake by plants of iron from iron chelates. *J. Plant Nutr.*, 7(1–5), 695–698.